

The Sessile Barnacles (Cirripedia) of the Bombay Coast

BY

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(With a map, four plates, and twenty-two text-figures)

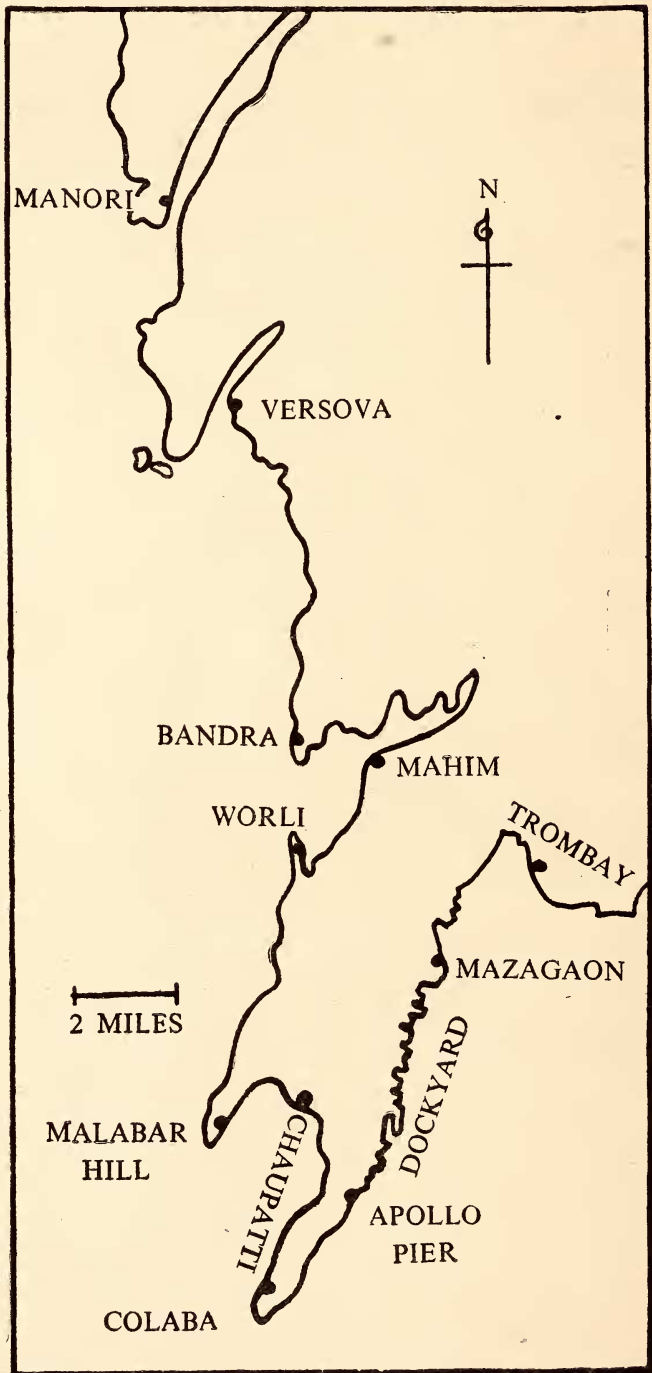
INTRODUCTION

Amongst the very varied forms belonging to the fouling community, the barnacles constitute an important group. They are commonly found on underwater structures such as hulls of ships, buoys, floating rafts and wharfs, jetties, chains, sea-water conduits, etc. On account of their great productivity, gregarious habit, and nature of settlement they are of greater importance than other fouling groups, and have attracted the attention of the biologist and the paint technologist.

Information on the Indian cirripedes is rather scattered and only during recent years have efforts been made towards a systematic survey of the barnacles of the Indian Ocean, the Bay of Bengal, and the Arabian Sea. Noteworthy contributions on this subject are those from Annandale (Daniel 1956) whose collections included specimens from Ceylon and the Andaman sea also. Nilsson-Cantell's (1938) study of collections made by Annandale covers 73 species and subspecies of sessile barnacles. Sundara Raj (1927) recorded five species of cirripedes from Krusadi Islands. The recent account of the cirripedia of Madras by Daniel (1956) has added to current knowledge of this group along the Indian coast.

In the course of studies on the incidence and nature of fouling at different places on the Bombay coast a large collection of barnacles has been made and it has been possible to add eleven more species, subspecies, varieties, and forms to the four already recorded along the Bombay shores (Bhatt & Bal 1960 ; Nilsson-Cantell 1938 ; Karande & Palekar 1963a).

The majority of the barnacles reported in this paper were collected from intertidal rocks and sea-walls, as well as from submerged structures such as buoys, fenders, piers, and frequently chains, anchors, and underwater hulls of ships of the Indian Navy. The intertidal collections were generally made from different localities around Bombay, viz. Naval



Map of Bombay and its surroundings

Courtesy : Bombay Natural History Society and B.F. Chhapgar & S.R. Sane

Dockyard, Apollo Pier, Colaba (Cuffe Parade), Mazagaon, Mahim, Bandra, Versova, and Manori Island (see Map on p. 140). The barnacles at Trombay were collected from panels suspended from Burmah-Shell Refineries Pier and those at Apollo Pier from this Laboratory's experimental raft moored at Middle Ground.

The usual method was employed of cleaning the valves, mouth-parts, and other appendages of the specimens with caustic potash. The diagrams were made with the help of the camera lucida.

CIRRIPEDES FROM BOMBAY

Suborder	..	BALANOMORPHA Pilsbry, 1916
Family	..	BALANIDAE Gray, 1825
Sub-family	..	BALANINAE Darwin, 1854
Genus	..	<i>Balanus</i> Da Costa, 1778

Subgenus *Megabalanus* Hoek, 1913

- 1a. *Balanus tintinnabulum* var. *tintinnabulum* Linne, 1758
- 1b. *Balanus tintinnabulum* var. *zebra* Darwin, 1854

Subgenus *Balanus* Da Costa, 1778

- 2a. *Balanus amphitrite* var. *variegatus* Darwin, 1854
- 2b. *Balanus amphitrite* var. *communis* Darwin, 1854
- 2c. *Balanus amphitrite* var. *hawaiiensis* Broch, 1922
- 2d. *Balanus amphitrite* var. *cochinensis* Nilsson-Cantell, 1938
- 2e. *Balanus amphitrite* var. *denticulata* Broch, 1927
- 2f. *Balanus amphitrite* var. *insignis* Nilsson-Cantell, 1938
- 2g. *Balanus amphitrite* var. *venustus* Darwin, 1854
3. *Balanus calidus* Pilsbry, 1916

Subgenus *Chirona* Gray, 1835

- 4a. *Balanus amaryllis* forma *euamaryllis* Broch, 1922
- 4b. *Balanus amaryllis* forma *nivea* Gruvel, 1905

Subfamily TETRACLITINAE Nilsson-Cantell, 1921

Genus *Tetraclita* Schumacher, 1817

5. *Tetraclita purpurascens* Wood, 1818

Family CHTHAMALIDAE Darwin, 1854

Genus *Chthamalus* Ranzani, 1817

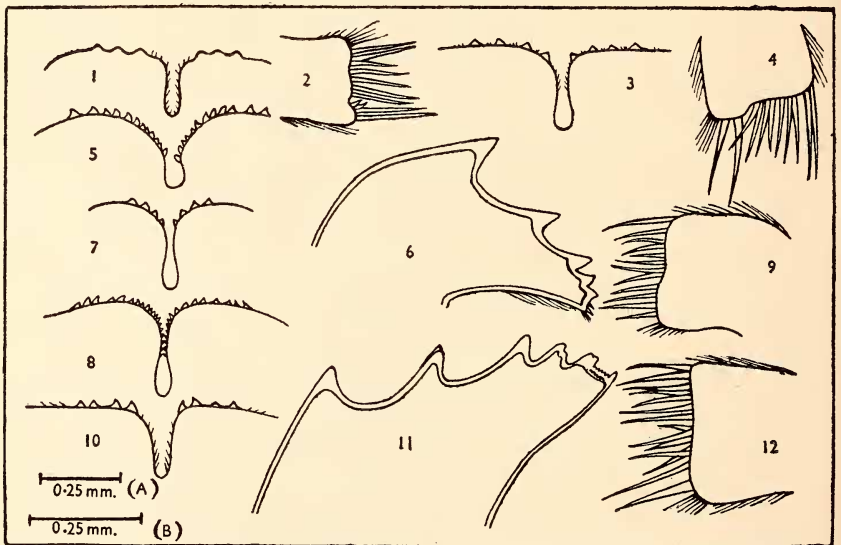
6. *Chthamalus malayensis* Pilsbry, 1916
7. *Chthamalus withersi* Pilsbry, 1916

DESCRIPTION OF SPECIES

1a. *Balanus tintinnabulum* var. *tintinnabulum* Linne, 1758

(Text-figs. 1 and 2 ; Plate I, Fig. 1 ; Plate III, Row 1)

Occurrence. Frequently occurring along Versova and Manori shores. Also found on hulls of ships.



Text-figures 1-12

1. *Balanus tintinnabulum* var. *tintinnabulum* : Labrum ; 2. ditto : Maxilla I ; 3. *Balanus amphitrite* var. *variegatus* : Labrum ; 4. ditto : Maxilla I ; 5. *Balanus amphitrite* var. *communis* : Labrum ; 6. ditto : Mandible ; 7. *Balanus amphitrite* var. *denticulata* : Labrum ; 8. *Balanus amphitrite* var. *hawaiiensis* : Labrum ; 9. ditto : Maxilla I ; 10. *Balanus amphitrite* var. *insignis* : Labrum ; 11. ditto : Mandible ; 12. ditto : Maxilla

NOTE: Figs. 1 and 2 drawn to scale (A); Fig. 3 to 12 to scale (B).

Remarks. This large-sized barnacle (Plate I, Fig. 1) measures up to 55 mm. in carino-rostral diameter. Tergum (Plate III, Row 1) with distinct articular ridge ; articular ridge of scutum (Plate III, Row 1) half as long as tergal margin and ending in a free point. Hairy labrum (Text-fig. 1) with three teeth on each half, one or two of them being some-

times reduced or absent. Specimens from Madras described by Daniel (1956) do not show any teeth on the labrum. Mandible with five teeth, the second and third being bifid; maxilla I (Text-fig. 2) with pair of long spines at apex, another at base, and ten smaller spines in between.

1b. **Balanus tintinnabulum** var. **zebra** Darwin, 1854

Balanus tintinnabulum var. *zebra* Darwin, 1854; Weltner, 1897; Gruvel, 1905; Stubbings, 1961.

(Plate I, Fig. 2)

Occurrence. Found on underwater hull of ship. This is the first record of this variety in Indian waters.

Remarks. On account of close resemblance, likely to be mistaken for *B. t. tintinnabulum*. However, Hiro (1939) has distinguished this variety from the others by the wide transversely striated radii with rose-tinted margins adjoining the parietes (Plate I, Fig. 2). Spur and articular groove of tergum narrow.

2a. **Balanus amphitrite** var. **variegatus** Darwin, 1854

(Text-figs. 3 and 4; Plate I, Fig. 3; Plate IV, Row 1)

Occurrence. Very common form. Occurs predominantly on submerged structures like piles, buoys, and test panels at Trombay and in Bombay Harbour. Also, invariably present on underwater hulls of ships.

Remarks. The specimens measure 20 mm. or more in carino-rostral diameter (Plate I, Fig. 3). Short articular ridge of tergum (Plate IV, Row 1) rounded at free end. Articular and adductor ridges of scutum (Plate IV, Row 1) fairly well developed.

Labrum hairy (Text-fig. 3), with four teeth on either side of notch. Mandible with five teeth, fourth and fifth of which are reduced. Maxilla I (Text-fig. 4) has broad step at basal end, a pair of long spines at apex, and another at base, and ten small spines in between.

2b. **Balanus amphitrite** var. **communis** Darwin, 1854

(Text-figs. 5 and 6; Plate I, Fig. 4; Plate IV, Row 2)

Occurrence. A widely occurring variety along Bombay shores. Generally found on rocks, piles, fenders, chains, etc. Also on shells of living or dead crabs and molluscs. Specimens are found to crowd in patches on underwater hulls of ships along with *B. a. variegatus*. Hiro

(1939) points out that in Japanese waters specimens do not settle on intertidal rocks whereas this is most common in Bombay waters.

Remarks. Carino-rostral diameter about 13-14 mm. (Plate I, Fig. 4). Scutum reddish brown (Plate IV, Row 2), with conspicuous white stripe along tergal margin (see Plate I, Fig. 4). Opercular valves smaller than in other varieties. Short articular ridge and short spur of tergum also distinguish this variety from others in *amphitrite* series. Articular ridge of scutum (Plate IV, Row 2) extends half way along tergal margin. A small ridge along the adductor ridge marks an important distinguishing feature of this variety. As characteristic of the *amphitrite* series, each segment of the third cirrus has six recurved spines and six long spines. Deeply notched labrum (Text-fig. 5) with 12-13 spines on each half of hairy margin. Mandible (Text-fig. 6) has five teeth and one or two tooth-like spines at lower end.

2c. *Balanus amphitrite* var. *hawaiiensis* Broch, 1922

Balanus amphitrite Pilsbry, 1928.

(Text-figs. 8 and 9 ; Plate I, Fig. 5 ; Plate IV, Row 3)

Occurrence. Intertidal variety abundantly found on rocks along Chaupati Sea Face with *B. a. cochinensis* and *B. a. communis*. First recorded in Bombay by Bhatt & Bal (1960).

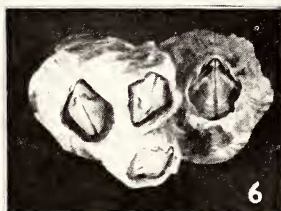
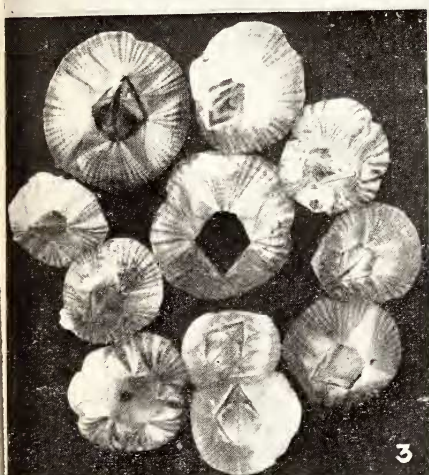
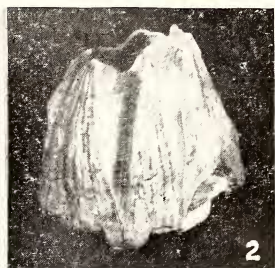
Remarks. The specimens measure 13-15 mm. in diameter. Parietes dirty white with violet vertical stripes (Plate I, Fig. 5). Easily distinguished from other varieties by sinuous suture between its opercular valves. A second distinctive external feature is horizontal disposition of opercular valves in contrast to inclined position in other varieties. Tergum of characteristic shape (Plate IV, Row 3), its pointed articular ridge slightly projecting out of scutal margin of tergum. Broad rounded spur short, crests for carino depressor muscles distinct, articular furrow broad. Scutum (Plate IV, Row 3) has well developed articular and adductor ridges. Labrum (Text-fig. 8) has about 18 teeth on either side of notch. Lower angle of mandible bears 2-3 spines. Maxilla I (Text-fig. 9) has 11-12 spines.

2d. *Balanus amphitrite* var. *cochinensis* Nilsson-Cantell, 1938

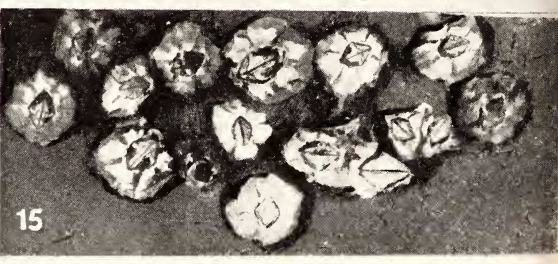
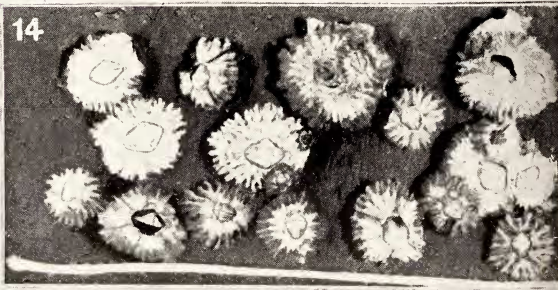
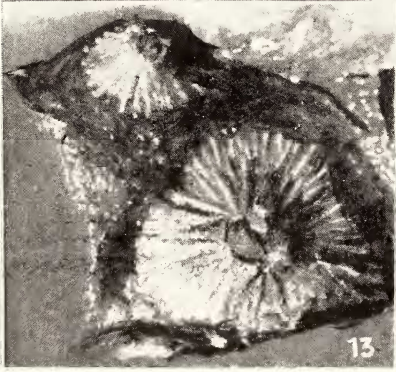
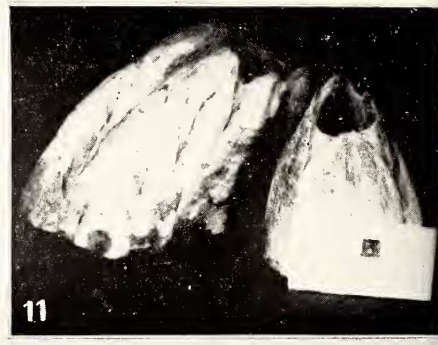
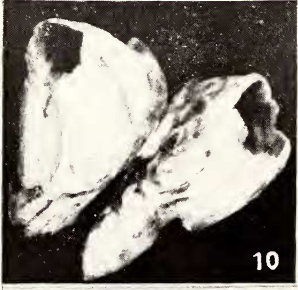
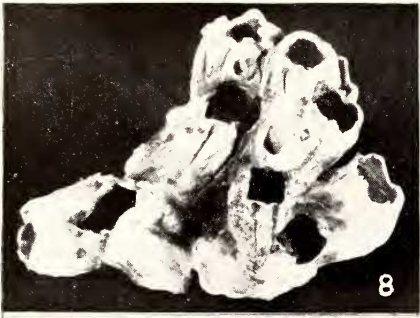
(Plate I, Fig. 6 ; Plate IV, Row 4)

Occurrence. Abundantly located on intertidal rocks at Chaupati. First described by Nilsson-Cantell (1938) from Cochin backwaters.

Remarks. The specimens measure 12-13 mm. in carino-rostral diameter (Plate I, Fig. 6). Distinguishable from *B. a. communis* by absence of white stripe along tergal margin of scutum. Opercular valves (Plate



1. *Balanus tintinnabulum* var. *tintinnabulum*; 2. *Balanus tintinnabulum* var. *zebra*; 3. *Balanus amphitrite* var. *variegatus*; 4. *Balanus amphitrite* var. *communis*; 5. *Balanus amphitrite* var. *hawaiiensis*; 6. *Balanus amphitrite* var. *cochinensis*; 7. *Balanus amphitrite* var. *denticulata*



8. *Balanus amphitrite* var. *insignis*; 9. *Balanus amphitrite* var. *venustus*; 10. *Balanus calidus*; 11. *Balanus amaryllis* forma *eumaryllis*; 12. *Balanus amaryllis* forma *nivea*; 13. *Tetractita purpurascens*; 14. *Chthamalus malayensis*; 15. *Chthamalus withersi*

IV, Row 4) closely conform to description given by Nilsson-Cantell (1938). Labrum has about 15 teeth extending within notch. Typical *amphitrite* mandible, with one or two spines on lower angle.

2e. ***Balanus amphitrite* var. *denticulata*** Broch, 1927

(Text-fig. 7 ; Plate I, Fig. 7 ; Plate IV, Row 5)

Occurrence. Found at Trombay and in Bombay Harbour.

Remarks. Carino-rostral diameter *c.* 8-10 mm. (Plate I, Fig. 7). Parietes dull white with very faint thin violet lines (Stubbings 1961), unlike var. *communis* where they are broader and darker. Opercular valves (Plate IV, Row 5) similar to those of West African specimens described by Stubbings (1961). Spur of tergum slightly longer than in var. *communis*. Valves generally weak. Drawn-out carinal margin at apex of the tergum in Bombay specimens is also seen in West African forms. Labrum (Text-fig. 7) has four teeth on each half, as noted by Stubbings (1961) in his specimens. As pointed out by him the separation of this variety from var. *communis* is virtually impossible without examination of the labrum. Mandible with five teeth.

2f. ***Balanus amphitrite* var. *insignis*** Nilsson-Cantell, 1938

(Text-figs. 10-12 ; Plate II, Fig. 8 ; Plate IV, Row 6)

Occurrence. Generally found on test panels at Trombay. Earlier reported from Cochin by Nilsson-Cantell (1938).

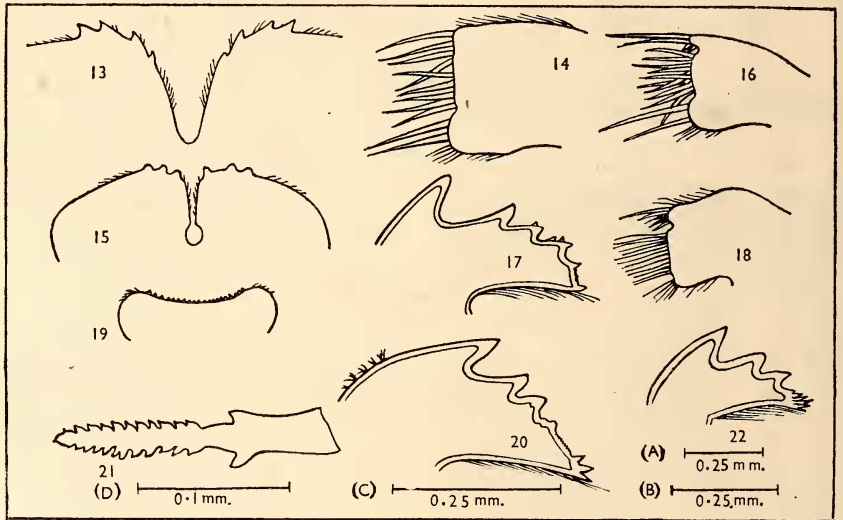
Remarks. Cylindrical in form. Specimens measure about 15 mm. in carino-rostral diameter (Plate II, Fig. 8). Dull white parietes with indistinct pinkish vertical lines. Shell base is strong and porous. The opercular valves, typical of this variety, are covered by yellow epidermis. Narrow tergum, with long curved spur (Plate IV, Row 6). Carino-basal margin curved inside and crests for depressor muscles distinct. Occludent margin of scutum (Plate IV, Row 6) thick. Labrum has four teeth on each half of hairy margin (Text-fig. 10), sometimes one or two being reduced. Mandible has five teeth (Text-fig. 11), the second bifid, the fourth and fifth spinose. Lower angle bears one or two spines. Maxilla I (Text-fig. 12) has 12 spines.

2g. ***Balanus amphitrite* var. *venustus*** Darwin, 1854

(Text-fig. 13 ; Plate II, Fig. 9 ; Plate IV, Row 7)

Occurrence. Occasionally found on test panels on experimental raft in Bombay Harbour.

Remarks. The specimens measure 20 mm. in carino-rostral diameter (Plate II, Fig. 9). Pale pink parietes have rosy vertical cut lines. Basiscarinal margin of tergum larger than that found in other varieties and



Text-figures 13-22

13. *Balanus amphitrite* var. *venustus* : Labrum ; 14. *Balanus calidus* : Maxilla I ; 15. *Balanus amaryllis* forma *euamaryllis* : Labrum ; 16. ditto : Maxilla I ; 17. *Tetraclita purpurascens* : Mandible ; 18. ditto : Maxilla I ; 19. *Chthamalus malayensis* : Labrum ; 20. ditto : Mandible ; 21. ditto : Toothed spine ; 22. *Chthamalus withersi* : Mandible

NOTE. Figs. 15 and 16 drawn to scale (A) ; Fig. 13, 14, 17-19, and 22 to scale (B) ; Fig. 20 and 21 to scales (C) and (D) respectively

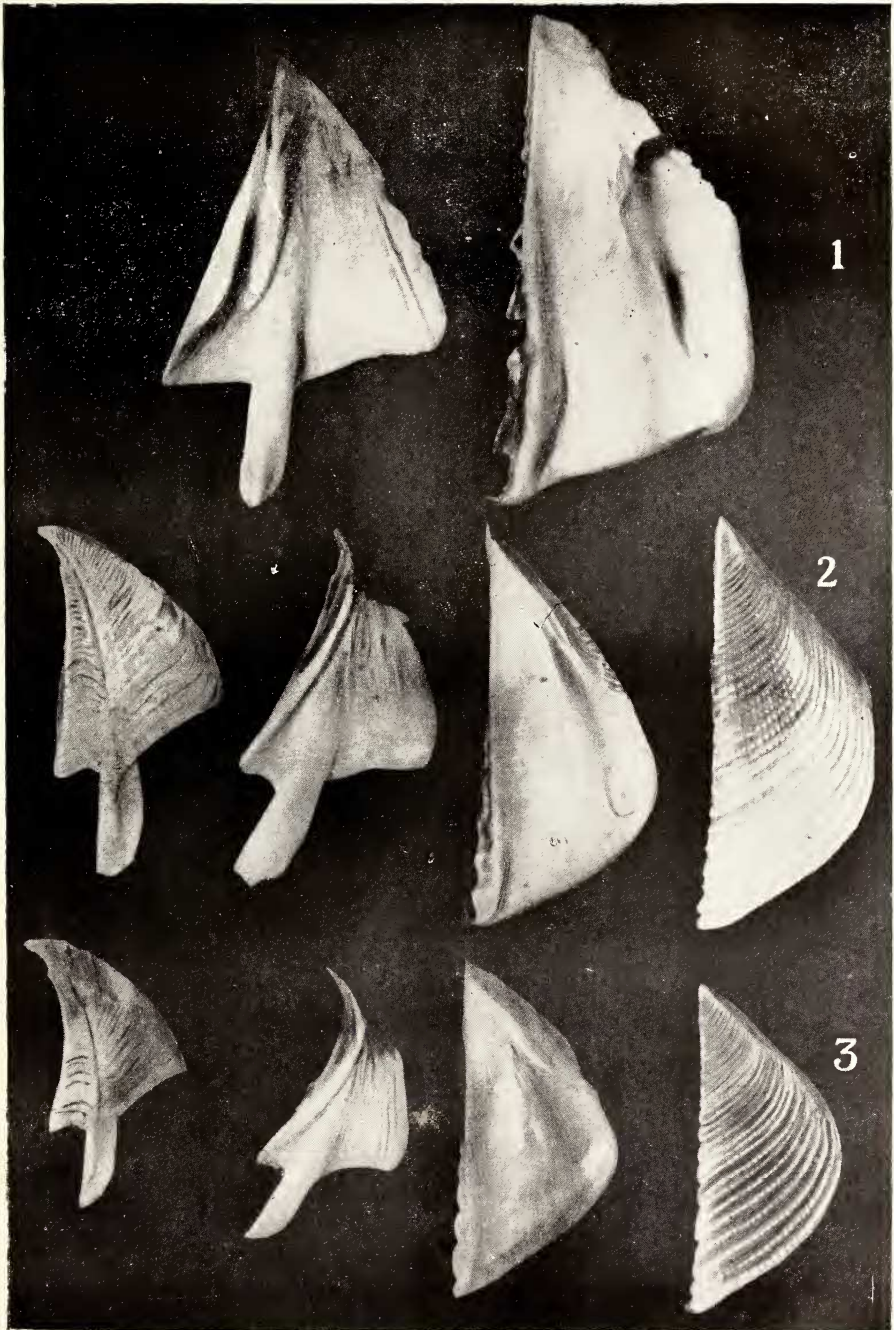
hollowed out (Plate IV, Row 7). Spur uniformly broad, and slightly larger than basi-scutal margin. Spur-fasciole broad. Scutum has distinct growth lines (Plate IV, Row 7). Articular ridge of scutum extends slightly more than half the length of tergal margin. Adductor ridge distinct. Pit for lateral depressor muscles deep. Labrum has four teeth on either side of notch (Text-fig. 13). Mandible has five teeth, fourth and fifth being reduced.

3. *Balanus calidus* Pilsbry, 1916

Balanus spongicola var. *with the walls slightly folded longitudinally* Darwin, 1854.

(Text-fig. 14 ; Plate II, Fig. 10)

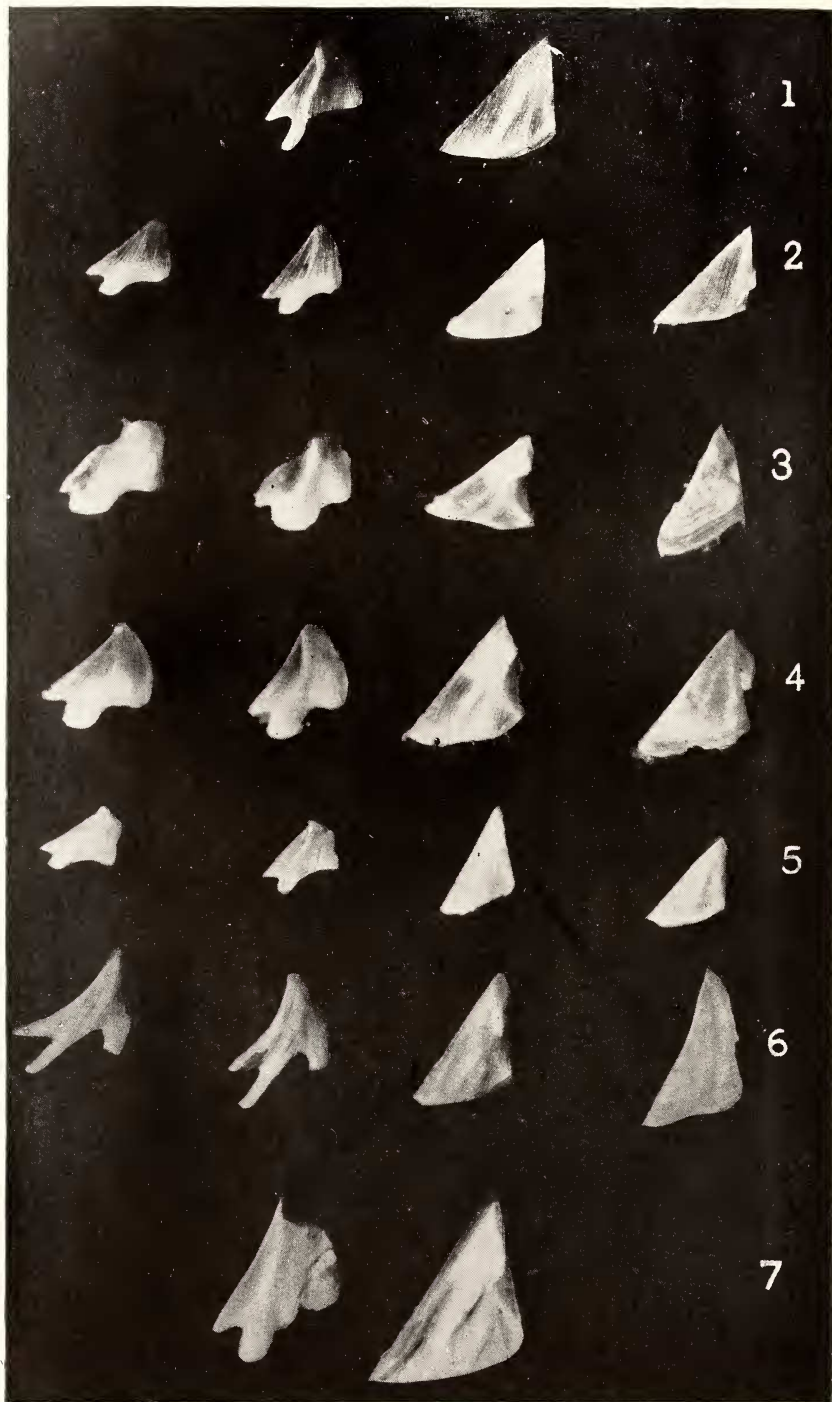
Occurrence. Only two specimens, encountered on test panels on experimental raft moored in Bombay Harbour. Daniel (1956) recorded this species from Madras for the first time in India.



Opercular valves of Barnacles

Row 1. *Balanus tintinnabulum* var. *tintinnabulum*; Row 2. *Balanus amaryllis* forma *euamaryllis*; Row 3. *Balanus amaryllis* forma *nivea*

NOTE. From left to right in each row : tergum outer view, tergum inner view, scutum inner view, and scutum outer view



Opercular valves of Barnacles

Row 1. *Balanus amphitrite* var. *variegatus*; Row 2. *Balanus amphitrite* var. *communis*; Row 3. *Balanus amphitrite* var. *hawaiiensis*; Row 4. *Balanus amphitrite* var. *cochinensis*; Row 5. *Balanus amphitrite* var. *denticulata*; Row 6. *Balanus amphitrite* var. *insignis*; Row 7. *Balanus amphitrite* var. *venustus*

NOTE. From left to right in each row : tergum outer view, tergum inner view, and scutum outer view

Remarks. Tubulo-conical in shape. Carino-rostral diameter of specimens 20 mm. (Plate II, Fig. 10). Radii narrow and oblique, with crenated edges. Spur of tergum slightly curved. Scutum has distinct growth lines, and articular ridge half as long as tergal margin. Labrum has four teeth on either side of median notch. Mandible has five teeth. Maxilla I with poorly developed lower step, and bears pair of long spines similar to those on upper angle ; between the two pairs of spines about 7-8 short spines (Text-fig. 14).

4a. **Balanus amaryllis** forma **euamaryllis** Broch, 1922

(Text-figs. 15 and 16 ; Plate II, Fig. 11 ; Plate III, Row 2)

Occurrence. Very common in Bombay Harbour, Trombay, Versova, and on hulls of ships.

Remarks. Carino-rostral diameter of specimens from 30 to 50 mm. (Plate II, Fig. 11). Articular and adductor ridges of tergum (Plate III, Row 2) very poorly developed ; broad spur crenated along free end. Articular and adductor ridges of scutum also weakly developed (Plate III, Row 2). Labrum deeply notched, and bears three teeth on each half of hairy margin (Text-fig. 15). Mandible has five teeth. Maxilla I (Text-fig. 16) has distinct upper and lower steps with two long spines on each, and 9-10 sub-equal spines in between the steps ; a notch at the base of the upper step has three to four smaller spines.

4b. **Balanus amaryllis** forma **nivea** Gruvel, 1905

(Plate II, Fig. 12 ; Plate III, Row 3)

Occurrence. Common at Manori. Also noted on hulls of ships.

Remarks. Carino-rostral diameter of specimens 25 mm. (Plate II, Fig. 12). Radii crenulated and narrower than in forma *euamaryllis*. This form is distinguishable externally from forma *euamaryllis* by its smooth shell and uniformly disposed, distinct, longitudinal lines on parietes. As noted by Daniel (1956) sculpture on opercular valves (Plate III, Row 3) of this species less developed than in forma *euamaryllis*. Mouth parts similar to those of forma *euamaryllis*.

5. **Tetraclita purpurascens** Wood, 1818

(Text-figs. 17 and 18 ; Plate II, Fig. 13)

Occurrence. First reported from Madras by Daniel (1956), and subsequently by Bhatt & Bal (1960) from Bombay. Found in abundance on intertidal rocks at Cuffe Parade.